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MILITARY SPACE PROJECTS

REPORT OF PROGRESS
FOR
JANUARY - FEBRUARY 1960

DEPARTMENT OF DEFENSE

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MILITARY SPACE PROJECTS

JANUARY AND FEBRUARY 1960

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OFFICE OF THE DIRECTOR
OF
DEFENSE RESEARCH AND ENGINEERING
Department of Defense
Washington 25, D.C.

Approved J.B. Macauley
for Herbert F. York
Director

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DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON 25, D. C.

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: Progress Report on Military Space Projects for January and February 1960

Progress on the major Department of Defense Space Projects during January and February 1960 is presented in the attached Military Space Projects Report.

In association with the preparation of these reports by my office, the reporting period has been adjusted one month. Future Military Space Project Reports will cover a full three month period.

Highlights of the report have been included in your letter of transmittal to the President, which I recommend that you sign.

J B Macauley
for Herbert F. York

Inclosure - 1
Military Space Projects Report

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THE SECRETARY OF DEFENSE
WASHINGTON

April 11, 1960

Dear Mr. President:

I am forwarding herewith the Military Space Projects Report for the period of January and February 1960.

One (1) MIDAS and two (2) DISCOVERER launchings were made during February 1960. Unfortunately, due to malfunctions during the boost phase, none were successful in placing a vehicle in orbit. Continuing effort and renewed emphasis is being placed on improving the reliability of components and system testing. Several DISCOVERER, MIDAS and SAMOS vehicles and payloads are nearing completion and it is hopefully expected that a number of successful launchings will be achieved during the current quarter. Tentatively, launching of the second MIDAS, DISCOVERER XI and XII and the second TRANSIT are scheduled for this month.

Project NOTUS (Communication Satellites) is being redirected with increased emphasis placed on an ultimate 24-hour global satellite communication system. The former medium orbit SAC POLAR satellite systems (STEER and TACKLE) and the former 24-hour global system (DECREE) are being reoriented to provide a revised 24-hour global system (ADVENT). The interim communication satellite system (COURIER) is proceeding as previously scheduled with the first launching scheduled for July 1960.

There is included herein a report of progress on the SATURN Project. However, inasmuch as the transfer of the SATURN Project to NASA was officially completed in March, no further progress reports will be made thereon. However, this vehicle has potential military application and the Department of Defense will continue to follow the project with considerable interest and assist in the development thereof insofar as practicable.

With great respect, I am

Faithfully yours,

James H. Douglas
Deputy

Inclosure - 1
Military Space Projects Report

The President

The White House

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PROJECT HIGHLIGHTS

During January and February 1960

On 4 February 1960, DISCOVERER IX was launched from the Pacific Missile Range. The final count-down and lift-off were normal. Instrumentation indicated early termination of booster thrust and short operation of the second-stage engine. Orbital velocity was not obtained. The AGENA vehicle impacted in the ocean about 400 miles south of the launch site. DISCOVERER X was launched on 19 February 1960. Immediately after lift-off, the THOR booster started pitch oscillations and the command destruct signal was sent at T-plus 56.4 seconds.

The first MIDAS flight test vehicle was launched from the Atlantic Missile Range on 26 February 1960. A satellite orbit was not obtained because of a malfunction or failure, which occurred during the boost phase. Preliminary indications are that a malfunction occurred during the firing of the retro-rockets to provide separation of the booster from the AGENA vehicle. The second MIDAS launching has been scheduled for April 1960.

NOTUS Project (Communication Satellites) is being redirected with an increased emphasis towards an ultimate 24-hour global satellite communication system. Former medium-orbit SAC POLAR satellite systems (STEER and TACKLE) and the former 24-hour global communication system (DECREE) are being reoriented to provide a revised 24-hour global system (ADVENT). In the case of the interim communication satellite system (COURIER), the program is currently limited to two (2) satellite launchings, as previously scheduled, with the first launching scheduled for July 1960 and the second launching for September 1960.

Fabrication of the second-stage vehicles for the first three SAMOS flight tests is proceeding on schedule. These vehicles will carry a combination visual/ferret payload. Visual (photographic) and ferret (electromagnetic) payloads for the first flight test have been delivered and are undergoing functional tests and preparations for installation in the AGENA vehicle. The first launching of a SAMOS vehicle is scheduled for September 1960.

The over-all program planning and objectives of the SHEPHERD Project (tracking network) are being carefully re-evaluated. The re-evaluation is for the purpose of re-assessing the present and long-range requirements for (1) a SPASUR (dark satellite fence) system, (2) the requirements for additional sensor elements for the detection system, and (3) the national requirements for a Space Surveillance Control Center, which will receive data from any and all sensor systems, compute space vehicle orbits and provide satellite position predictions. This re-assessment of the SHEPHERD Project will include an over-all evaluation of world-wide tracking and sensor requirements in cooperation with the National Aeronautics and Space Administration.

The second attempt to launch a TRANSIT vehicle (navigation satellite) is scheduled for April 1960. This vehicle will be similar to the first TRANSIT vehicle, will transmit on four frequencies: 54, 162, 216 and 324 megacycles, and will include new type nickel-cadmium batteries with increased storage capacity.

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TOPICAL SUMMARY

DISCOVERER PROJECT

(RESEARCH AND DEVELOPMENT SATELLITES)

Project Objectives - Development and testing of components for Military Space Technology Program.

1. Project Objectives

a. The objectives of the DISCOVERER Satellite Program are to conduct research and development on components, equipment, instrumentation, propulsion, data processing, communications, capsule recovery and operating techniques all dealing with military space technology.

b. The DISCOVERER Project consists of design, development, and launch of 29 two-stage satellite vehicles. The first stage is the THOR IRBM, the second stage the AGENA satellite vehicle. Of the AGENA vehicles, 17 are the "A" configuration, 12 the "B" configuration. Later vehicles will use the DM-21 first stage (A THOR IRBM specially designed for space booster duties by removal of all components not necessary for booster missions) and the AGENA "B" second stage (An AGENA vehicle modified to carry double propellant load, and equipped with a restart engine capable of longer burning duration). This program will provide:

(1) Research and component development in support of the SAMOS, MIDAS, and certain other programs using AGENA satellite vehicles.

(2) Tests of the ground communciations and tracking network developed for the above programs.

(3) Flight test of the AGENA vehicle and subsystems.

Program objectives include development of reliable systems for Military satellite programs.

2. Prime Program Objectives

a. Flight test of the satellite vehicle airframe, propulsion, guidance, control system, auxiliary power supply, and telemetry, tracking and command equipment.

b. Attaining satellite stabilization on orbit.

c. Obtaining satellite internal thermal environment data.

d. Test the techniques for recovery of a capsule ejected from an orbiting satellite.

e. Test of ground support equipment and development of personnel proficiency.

f. Conducting bio-medical experiments involving the orbiting and recovery of mice and small primates.

This program evolved from Weapon System 117L, Advanced Reconnaissance Satellite.

3. History

The DISCOVERER Project originated as part of Weapon System 117L at the Air Force Ballistic Missile Division. In early 1958, the program management was transferred to ARPA, and subsequently divided into the DISCOVERER, SAMOS, and MIDAS Projects. After several reorientations, the programs evolved into the present configurations. Ten (10) DISCOVERER vehicles have been launched. Six (6) achieved successful orbits, all very close to the planned orbit. These are the heaviest satellites to be placed in orbit by an intermediate range missile by the free world (1,700 lbs plus). Four of these six satellite vehicles achieved complete attitude stablization in orbit. This is a major requirement for the success of the SAMOS, MIDAS, and other programs using this vehicle. The program has been quite successful in providing flight test data for refinement of the complex systems required for advanced military satellites.

DISCOVERER IX was launched on 4 February. It failed to attain orbit due to insufficient velocity.

4. Flight Test Progress

DISCOVERER IX was launched from Vandenberg Air Force Base on 4 February 1960. The countdown was smooth and liftoff occurred with all ground and vehicle equipment operating properly. No unusual phenomena were observed during the initial ascent portion of the flight, but instrumentation indicated early termination of booster thrust and short operation of second-stage engine during the latter portion of the trajectory. Subsequent data analysis indicated the following sequence of events as the probable cause for the malfunction:

a. The THOR booster engine shut down about 19 seconds early, resulting in a booster velocity 4,000 feet per second less than nominal.

b. The helium quick-disconnect malfunctioned at liftoff, causing loss of AGENA vehicle propellant tank pressurization. This resulted in premature shutdown of the AGENA propulsion system. Either of the above events would have prevented the attainment of orbital velocity. The AGENA impacted in the ocean about 400 miles south of the launch site.

DISCOVERER X, launched on 19 February, was destroyed by Range Safety because of THOR autopilot malfunction.

DISCOVERER X was launched from Vandenberg Air Force Base on 19 February 1960. The countdown was smooth, and launch occurred on the first attempt. Immediately after liftoff, THOR booster pitch oscillations began and a command destruct signal was sent at T plus 56.4 seconds. Many major vehicle components were recovered for examination. Preliminary analysis indicated that the malfunction was in the THOR autopilot. Extensive studies are underway to ascertain and correct the conditions leading to early termination of both of the flights.

DISCOVERER XI scheduled for launch in mid-March.

5. Future Flights

DISCOVERER XI was scheduled for launch from Vandenberg Air Force Base during mid-March. This vehicle will carry an instrumented recovery capsule, plus advanced engineering test instrumentation.

TECHNICAL STATUS

All AGENA "A" vehicles are complete. The first AGENA "B" is complete and at Santa Cruz Test Base.

1. Airframe

All of the AGENA "A" vehicles are at Vandenberg Air Force Base in various stages of preparation for launch. Three of the first four AGENA "B" (double propellant capacity, extended burn engine) vehicles are in the Lockheed Modification and Checkout Center, Sunnyvale, California, in various stages of completion. The first AGENA "B" scheduled for flight is complete and is at the Santa Cruz Test Base. This vehicle is planned for use on the 17th flight with the first THOR DM-21 Block I booster. No problems with the airframe are known or expected.

2. Propulsion

The single-burn engine is fully developed. A single-restart long-burn engine is under development.

a. The initial AGENA vehicles were delivered with the Bell Aircraft LR81-Ba-3 rocket engine originally developed for the B-58 aircraft. The engine was subsequently modified to burn Unsymmetrical Di-methyl Hydrazine fuel (instead of JP-4) for additional performance, becoming the LR81-Ba-5 engine. In late 1959, a program was initiated to develop an engine of still greater performance. The XLR81-Ba-7 is being developed to provide a single restart and extended burn-time capability.

Two XLR81-Ba-7 engines completed Preliminary Flight Rating Tests.

b. Two XLR81-Ba-7 engines completed Preliminary Flight Rating Tests at Bell Aircraft Company during the quarter. The data will now be reviewed and the engines disassembled and inspected. The XLR81-Ba-7 will power the first four AGENA "B" vehicles.

An extended nozzle is being developed for the restart engine to increase performance.

c. A program to develop an extended nozzle for the restart engine is underway at Bell Aircraft Company. This configuration will be designated the XLR91-Ba-9. The extended nozzle will provide increased performance at altitude. A titanium nozzle has been successfully tested, and this material will probably be adopted for the nozzle.

Enlarged thrust chamber version of the restart engine is being tested.

d. The third phase of hot firings of the XLR81-Ba-9 engine was initiated at the Santa Cruz Test Base during February. This engine is programmed for use on the fifth and subsequent AGENA "B" vehicles replacing all previous configurations.

3. Guidance and Control

A light weight hydraulic pump is being developed.

A fuel-powered hydraulic control system is being developed to save both weight and electrical power. This system, now powered by an electric motor, provides power for satellite engine gimballing to provide directional control. The fuel-powered unit is driven by fuel diverted from the fuel pump through a hydraulic motor. This, in turn, drives a hydraulic pump. The unit is planned for incorporation into the first AGENA "B" extended chamber configuration vehicle, about the 22nd flight.

Biomedical recovery capsule tests were continued during the report period to check capsule design.

4. Biomedical Recovery Capsule

Tests of the biomedical capsule designed for a small primate were resumed in the Lockheed high altitude temperature simulation chamber on 8 February. The General Electric capsule tested utilized several modifications and techniques derived from thermal profile tests in November and proof tests by the School of Aviation Medicine in December. These include increased cooling capacity, refinement of sensor-to-animal attachment methods for telemetry readout, relocation of life chamber components, and reprogramming of psychomotor response stimuli. The first full-duration test of the capsule containing a live primate was completed on 12 February. This 55-hour test, simulating a complete flight, was initiated at Vandenberg Air Force Base with the primate sealed in the capsule. Test results were excellent.

DISCOVERER facilities are shared with the SAMOS and MIDAS Projects.

5. Facilities

The majority of the DISCOVERER facilities are shared with SAMOS and MIDAS. The facilities information contained in those sections of the report is generally applicable to DISCOVERER. DISCOVERER facilities are complete and operational. The following are the key facilities for the DISCOVERER Project:

a. The Lockheed Missiles and Space Division Plant at Sunnyvale, California, where AGENA manufacturing, modification, and checkout are performed.

b. The Satellite Test Center at Sunnyvale, operated by Lockheed and the Air Force. During orbital tests, the systems are operated from this Center.

c. Santa Cruz, California, Test Base. This base provides facilities for hot firings of satellite vehicle propulsion systems prior to acceptance.

d. The Vandenberg Air Force Base launch site.

e. Tracking stations at Vandenberg Air Force Base and Point Mugu, California; Kodiak, Alaska; and Kaena Point, Hawaii.

f. The Hawaiian Recovery Control Center.

SAMOS PROJECT

(RECONNAISSANCE SATELLITES)

SAMOS to provide both Visual (Photographic) and Ferret (Electromagnetic) data.

1. Project Objective

a. The objective of the SAMOS project is the development of a reconnaissance system utilizing polar orbiting satellites to collect and process visual (photographic) data and ferret (electromagnetic) data. The SAMOS system is expected to acquire a great amount of technical intelligence regarding enemy military and industrial strength.

Acquisition of data by capsule recovery.

b. Two approaches are being developed for acquiring intelligence data: (1) the recovery system - for visual data - in which a capsule is ejected from the satellite and recovered, and (2) the electronic data readout system - for both visual and ferret - in which data is transmitted to ground stations.

Dual payload scheduled for first 3 flights.

c. A combined visual/ferret payload will be tested on the first 3 flights. The first seven ferret payloads (F-1 and F-2) will include progressively more complete installations of receivers and antennas to provide increasingly greater electronic measurement capability. The major portion of the hardware components developed for the original program are usable in the reoriented program.

AGENA vehicles for first 3 flights progressing on schedule.

2. Technical Progress

a. Second-Stage Vehicles

Work on the second-stage (AGENA) vehicle for the first SAMOS flight is 70 percent complete in the Modification and Checkout Center. This vehicle will be the first of three to carry a combination visual and ferret (E-1 and F-1) payload. Assembly of the other two vehicles is proceeding on schedule. Interior design of the AGENA vehicles for flights 4 and subsequent is proceeding on schedule. A common airframe design from the forward equipment compartment aft is being used for these vehicles and for MIDAS vehicles (flights 4 and subsequent). Equipment installations need not be interchangeable. Substantial progress has been made on the design of the vehicle for the E-5 payload.

b. Payloads

(1) Visual (Photographic) Reconnaissance System

Visual Reconnaissance System payloads are being developed in a minimum number of configurations to attain readout and recovery mission objectives. The designation and purpose of each configuration is as follows:

Readout:

E-1--Component Test Payloads
E-2--Steerable Reconnaissance Payload (with 20-foot ground resolution)

Recovery:

E-5--High Resolution Recoverable Payload (with 5-foot ground resolution)

Functional testing successful on first visual payload.

(a) E-1 Payloads - The first E-1 flight article payload was delivered to Lockheed Missiles and Space Division on 8 February. Functional tests were performed on all components. During a preliminary functional test, with the payload mounted in the collimator, a system resolution of greater than 94 lines per millimeter was obtained. The payload was subjected to a series of three 19-hour tests under simulated orbital conditions, with satisfactory results obtained. The second E-1 payload is undergoing quality evaluation testing at Eastman Kodak. This is a spare payload for component replacement only and will be delivered unassembled to Lockheed Missiles and Space Division before 15 March.

Environmental tests completed on E-2 thermal model payload.

(b) E-2 Payloads - Delivery of the first E-2 payload is scheduled for July. Environmental tests of the thermal model E-2 payload were completed on 28 January in the high altitude temperature simulation chamber. Test objectives were achieved. Changes in the payload housing surface and heater power requirements are being made as a result of test data.

Design progress of E-5 system on schedule.

(c) E-5 Payloads - Design of the high acuity panoramic camera system is proceeding satisfactorily. The special optical glass for the lens elements, which has been ordered from West Germany, will be delivered to the Itek Corporation in mid-April. The Development Test Plan for the recovery capsule has been published, including payload test requirements from checkout through post-launch operations. Avco Corporation is conducting wind tunnel tests on various recovery capsule configurations as a parallel effort with Lockheed Missiles and Space Division aerodynamics studies.

Ground support complex operated successfully.

(d) Ground Support Equipment - The complete visual reconnaissance system ground support equipment complex was operated with the E-1 payload during February. All equipment operated satisfactorily.

(2) Ferret (Electromagnetic) Reconnaissance System

Ferret Reconnaissance System payloads are being developed in a minimum number of configurations. The designation and purpose of each configuration is as follows:

F-1--R&D Test Payloads

F-2--Digital General Coverage Payloads

F-3--Specific Mission Payloads

First two F-1 payloads being prepared for installation in AGENA vehicles.

(a) F-1 Payloads - The first two F-1 payloads are being prepared for installation in their respective AGENA vehicles at the Modification and Checkout Center. During payload evaluation tests conducted in January, a discrepancy was indicated in the pulse width measurement circuit. The circuit design is being studied in an effort to solve this problem. Efforts to solve the intermittent time counter errors encountered during systems testing of the third F-1 payload are progressing satisfactorily. Desensitizing the counter stages appears to be the most feasible solution. A breadboard of the desensitized time counter has been installed in an F-1 service test model payload and has been operated satisfactorily for 48 cycles of life testing (equal to approximately three days of orbital operation). The use of line filters is being studied as an additional effort. Separation tests of the vehicle nose cone were completed satisfactorily during January. Separation tests simulating vehicle-payload attachments were completed satisfactorily during February.

Concepts and characteristics of new F-2 and F-3 payloads defined.

(b) F-2 and F-3 Payloads - In accordance with the program reorientation, the concepts and basic characteristics for the new F-2 and F-3 payloads have been defined. Work statements in accordance with the new requirements are being prepared for Airborne Instruments Laboratory. Design and modification of some of the payload components affected by the change (i.e. payload structure and antenna assemblies) have been initiated.

F-1 data conversion equipment set for 25 March delivery.

(c) Ground Support Equipment - Delivery of the F-1 data conversion equipment to the Satellite Test Center, Sunnyvale, California, is scheduled for 25 March. Negotiations are underway for the changes to the F-2 and F-3 ground data handling equipment resulting from program reorientation.

Improved design for VHF antenna tested successfully.

c. Communications and Control Equipment

(1) Design of the exit VHF (Very High Frequency) antenna for the satellite vehicle ~~has been~~ refined, using a honeycomb dielectric to support the cavity. A weight reduction of 60 percent was realized and laboratory tests indicate satisfactory performance.

March delivery scheduled for UHF equipment.

(2) Systems and acceptance tests are being conducted on the UHF (Ultra High Frequency) ground equipment for the Vandenberg Air Force Base tracking and data acquisition station.

Equipment delivered for launch pad #1

d. Ground Support Equipment

(1) Ground Handling and Service Equipment - Equipment for Point Arguello launch pad #1 has been delivered and is scheduled to be completely installed and checked out by mid-May.

Propulsion system checkout units delivered to Vandenberg Air Force Base.

(2) Checkout Equipment - AGENA propulsion system checkout equipment was delivered to Vandenberg Air Force Base during February. Integration and acceptance testing of systems checkout complex 1A are in progress at the Modification and Checkout Center,

Sunnyvale, California. Complex 1A is a modification of the DISCOVERER vehicle checkout complex and will be used for both SAMOS and MIDAS vehicles.

Control equipment for launch pad #1 delivered in February.

(3) Launch Control Equipment - Manufacturing of launch control systems equipment for Point Arguello launch pad #2 is 80 percent complete. The equipment for launch pad #1 was shipped to Vandenberg Air Force Base on 18 February.

MIDAS PROJECT

(VERY EARLY WARNING SATELLITES)

MIDAS will provide early warning of ballistic missile attack.

1. Project Objective

The MIDAS project (Missile Defense Alarm System) is aimed toward establishing a series of satellites around the earth in polar orbits. These will carry payloads consisting of infrared detection scanners capable of detecting emanations from ballistic missiles being launched, as the missiles rise above the atmosphere.

First flight test vehicle launched on 26 February.

2. Flight Test Progress

a. The first MIDAS flight test vehicle was launched from Atlantic Missile Range on 26 February. Satellite orbit was not attained because of malfunctions which occurred during the boost phase.

Flight parameters for first flight.

b. The first MIDAS flight was planned to place the satellite vehicle into a 261 nautical-mile circular orbit.

Launch pad preparations.

3. Pre-launch Plans and Preparations

a. Electrical rewiring of launch pad 14 and pad umbilical drop tests were completed on schedule. Additional redundant electrical circuits were installed in the mast to provide increased reliability.

Ground support equipment tested satisfactorily.

b. Systems checkout of the ground support equipment were conducted successfully with no problems becoming apparent. Checkout of the ATLAS booster was conducted with completely satisfactory results.

Payload readout plan defined.

c. Ground stations at the Atlantic Missile Range, Kaena Point (Hawaii) and Vandenberg Air Force Base were scheduled to perform payload-to-ground data link readout. All three stations were to have tape recorded the satellite system--time data for processing, analysis and presentation on the command console of the ground presentation unit at the Satellite Test Center, Sunnyvale, California. In addition, real-time readout was to have been performed on the ground presentation unit at Vandenberg Air Force Base. Motion pictures of the real-time ground presentation were to have been made, with system-time indicated on each frame.

Simulators permit pre-launch training.

d. Second-stage vehicle simulators were delivered to Atlantic Missile Range, Kaena Point and Vandenberg Air Force Base early in February. These units were used for training and familiarization in vehicle handling, checkout, tracking and readout; and for electrical checkout of associated ground equipment. Each unit, consisting of two equipment racks, is capabl of receiving and transmitting commands and simulating the characteristics of the infrared payload and communications subsystem of an orbiting MIDAS satellite.

Infrared targets planned for orbital readout testing.

e. A series of targets had been planned to test the infrared readout capability of the orbiting MIDAS satellite. Included were ATLAS and TITAN missile launches from the Atlantic Missile Range and ATLAS launch from Vandenberg Air Force Base, timed to coordinate with MIDAS passes. In addition, ten pyrotechnic targets were to have been ignited during night-time passes over Vandenberg Air Force Base and Edwards Air Force Base.

4. Technical Progress

AGENA vehicle at Atlantic Missile Range for second MIDAS flight.

a. Second-Stage Vehicles

Preparation of AGENA vehicle 1007 for installation on the second MIDAS flight vehicle is proceeding on schedule at the Atlantic Missile Range. This flight is scheduled for launch during April 1960.

Infrared scanner units shipped to Atlantic Missile Range.

b. Infrared Scanner Units.

Three of the flights 1 and 2 units were shipped to the Atlantic Missile Range during February and the fourth is in the Modification and Checkout Center. One of the units at the Atlantic Missile Range is the flight article for second MIDAS flight.

Infrared system tested on missile flights.

c. Infrared Payload Tracking Tests

The complete MIDAS system, including the infrared scanner unit, satellite-borne data link, ground data link, and operating personnel successfully tracked an ATLAS missile launched from Vandenberg Air Force Base on 29 January. The payload and satellite data link were set up outside the telemetry building to track the missile ascent. Data were transmitted to the tracking station via the data link system and tape recorded. On 4 February, the DISCOVERER IX launch was similarly tracked for 110 seconds. Analysis of the tapes on which the tracking information was recorded revealed that the target information obtained was highly satisfactory. The capability of the space and ground presentation equipment as installed at Vandenberg Air Force Base was established.

Fabrication of panels started.

d. Solar Auxiliary Power

Fabrication of the solar array panels was started on 8 February. The mockup of the entire array is nearly complete. A functioning 1/10 scale model of the array mechanism was completed during February.

AGENA reliability program defined.

e. Reliability Negotiations

Lockheed Missiles and Space Division and Bell Aircraft have completed a work statement for an AGENA engine reliability program.

TRANSIT PROJECT

(NAVIGATION SATELLITES)

Objectives.

1. Introduction

The objective of the TRANSIT Project is to provide an accurate and reliable means of precisely fixing the position of surface craft, submarines, and possibly aircraft on an all-weather global basis.

TRANSIT 1B Satellite launching scheduled for April 1960.

2. Navigation Satellite Flights

a. The second attempt to orbit an experimental TRANSIT satellite for tracking, navigating, and geodetic trials is scheduled for April 1960. This is designated TRANSIT 1B. The TRANSIT 1B satellite (see Figure 1) will transmit on four frequencies: 54, 162, 216, and 324 mc. It will use new type nickel-cadmium batteries which have a larger storage capacity than the cells used in the 1A satellite. The 1B will include a special device to provide a flight demonstration of the GREB/TRANSIT separation mechanism without jeopardizing the 1B flight objectives.

Launching of TRANSIT 2A Satellite is scheduled for May 1960.

b. The 2A satellite system diagrams and structural design have been completed. Most of the 2A components have been fabricated. This satellite will differ from 1A in orbital inclination and will incorporate a clock permitting precise worldwide time correlation. As a secondary experiment, 2A will carry the GREB satellite in pickaback fashion.

The TRANSIT 2B satellite, primarily a backup for 2A, will be structurally identical with it, but will incorporate a data storage system.

c. System design of the 2B is essentially complete, and the circuit design of memory and data logic is 90 percent complete. The preliminary system breakdown into component units is complete. The 2B will be able to store approximately 300 bits of digital information and to read out about 100 bits per second.

TRANSIT-ON-DISCOVERER launchings.

d. In cooperation with the Air Force, TRANSIT-type stable oscillators are being installed in several DISCOVERER satellites. DISCOVERERS IX and X failed to achieve orbit but signals were received from the airborne TRANSIT transmitters. Subsequent DISCOVERER satellites will carry TRANSIT transmitters until several transmitters have been successfully flown and doppler data read out by the Navy TRANSIT receiving stations. The purpose of these tests is to make a preliminary evaluation of the capabilities of the TRANSIT system for DISCOVERER tracking by comparing it with very long range tracking data and data obtained from optical tracking of a light flash.

3. Receiving Stations

Status of eight units being built by Naval Ordnance Test Station, China Lake, California.

a. In addition to the six fully instrumented ground receiving stations developed for TRANSIT use, the first of eight portable receiving stations which can be utilized in the TRANSIT program is complete. This station will be sent to Karamusel, Turkey, and will be operational during the launch of TRANSIT 1B. Of the eight portable receiving stations, five are TRANSIT program stations and three are being built for use by the Pacific Missile Range.

Experimental tracking equipment installed and checked out on USS OBSERVATION ISLAND.

b. The installation and preliminary checkout of the experimental tracking equipment aboard the POLARIS Weapon System Test Ship, USS OBSERVATION ISLAND (EAG-154), has been completed. This equipment records on magnetic tape doppler data received from the satellite for subsequent forwarding to the Applied Physics Laboratory, Howard County, Maryland station.

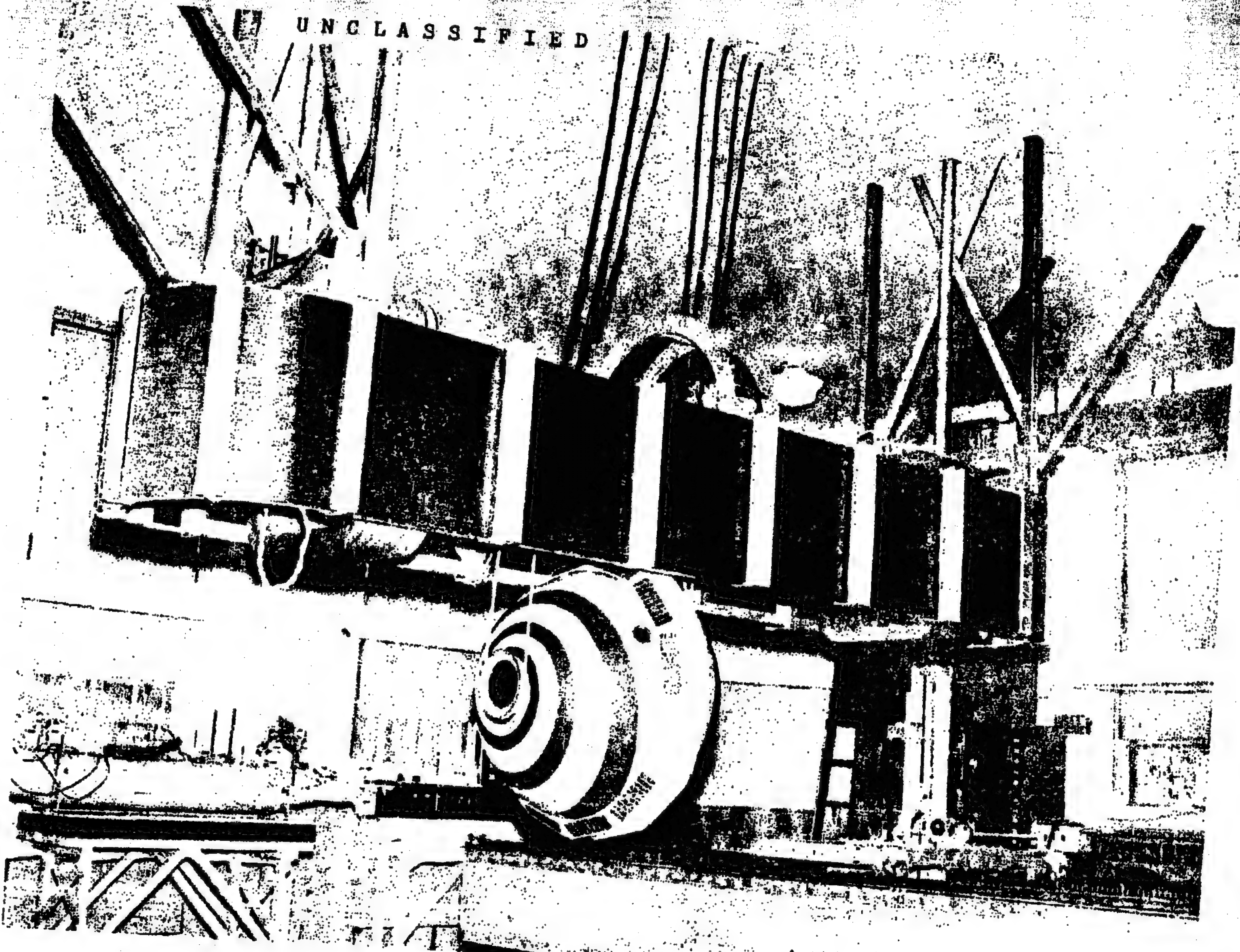

Figure 1. TRANSIT 1B Test Installation.

NOTUS PROJECT

(COMMUNICATION SATELLITES)

Satellite to be used for receiving and retransmitting messages.

1. Project Objective

a. The objective of the Communication Satellite Project (NOTUS) is the development of a military communication system, utilizing satellites to provide long-range radio communication links. The satellite communication system is expected to relieve the presently overcrowded trunking facilities and to improve reliability of global communication.

Project being further evaluated.

b. The Communication Satellite Project is being further evaluated. Program decisions on a reoriented program are expected to be reached at an early date.

COURIER - Delayed Repeater.

2. Delayed Repeater

The initial phase of the project is the development and operation of a delayed repeater satellite (COURIER) which will receive messages over one point and retransmit them over another point.

Program being reoriented to provide a single integrated R&D project called ADVENT.

3. Instantaneous Repeater

a. During this report period, plans were formulated to integrate the SAC Communication Satellite (STEER), the Advanced Polar Communication Satellite (TACKLE) and the 24-hour communications project (DECREE) into a single R&D project for a 24-hour global satellite communication system (ADVENT). The ultimate objective of this project is the provision of global communications on a real-time basis at microwave frequencies with a high channel wide bandwidth capacity, and to provide an ultra high frequency Polar capability for SAC as a by-product.

Fourteen flights tentatively scheduled in the 1961-1963 period.

b. To achieve the above stated objective, a series of four launches into a 5,600 nautical mile polar orbit is planned from the Pacific Missile Range in late 1961 and early 1962. Ten ATLAS CENTAUR Vehicles will be fired from the Atlantic Missile Range into a 19,300 nautical mile equatorial orbit. These flights, which include three National Aeronautics and Space Administration R&D vehicles, are scheduled during the 1962-1963 period.

4. Status - COURIER

COURIER launch dates determined: 15 July 1960 for 1A and 1 September 1960 for 1B.

a. General

At a meeting on 13 February 1960, between all principal Department of Defense agencies involved, agreement was reached for 15 July 1960 as the launch date for COURIER 1A and for 1 September 1960 as the launch date for COURIER 1B. Detailed milestone schedules have been prepared and are being closely monitored for all major phases of the program.

COURIER receiving equipment—fabrication and assembly of vans in progress.

b. Ground Station Equipment

Fabrication of all major component items has been initiated. The UHF receiving system prototype is nearing completion and should be ready for testing during the second week of March. The first VHF receiving system will also be completed at about the same time. The first complete set of vans for one ground station is available and installation of all equipment will be completed by late March 1960. The second set of vans should be completed by mid-April 1960.

COURIER antenna tower completed. Antennas being built and tested.

c. Ground Antenna

Rotary joint fabrication and testing work has been started and will continue through March. In-plant testing of these components will start 22 March. Testing of the first antenna feed assembly will start 15 April and subsystem testing of the first servo console will begin on 10 March. The tower for the first site has been delivered and is being erected at Camp Salinas, Puerto Rico. The second tower will be completed in May for installation at Deal Test Site, Fort Monmouth, New Jersey.

Fabrication of COURIER satellite equipment proceeding. Plans made for system tests with ground station and check-out van.

d. Satellite Equipment

Work is progressing with the design and fabrication of satellite components. Both mechanical and electrical design was reviewed and approved. The first prototype satellite will be delivered and compatibility tests of this model with the checkout van and ground station will be conducted in May 1960. The life test model will be completed by 15 May and two flyable model satellites will be delivered to the Atlantic Missile Range by the middle of June. The series of final acceptance tests will then be conducted.

Construction of the Puerto Rico COURIER site under way on schedule.

e. Ground Station Sites

(1) Work has been proceeding on schedule at Camp Salinas, Puerto Rico, Site No. 1. All preparatory work has been completed and tower erection is expected to be completed by 15 March. Station electrical wiring will be completed in early April, control equipment will be installed in April, radio frequency components in May and June, and radio vans the last two weeks in June. System testing and acceptance are scheduled for early July.

Work has been started on second site at Fort Monmouth.

(2) Site survey work for the second site has been started at Fort Monmouth. The contractor, Radiation, Inc., estimates that a minimum of twenty weeks will be required for complete installation. System testing and acceptance will be performed from 1 July to 22 July.

Preliminary studies completed on final stage vehicle configuration for ADVENT satellite.

5. Status - ADVENT

a. Final Stage Vehicle

Preliminary configuration studies of the final stage vehicle have been completed. These include detailed weight, power, thermal analysis and volume estimates. A method of controlling temperatures within the final stage vehicle has been developed, in which internal power is dissipated in the form of heat to maintain the required temperatures of critical components. Application of this concept permits the maintenance of vehicle temperatures independent of solar radiations and, therefore, unaffected by solar eclipses.

UHF frequencies allocated for ADVENT.

b. Communications Equipment Development

(1) The frequency allocation has been made for the communications subsystem. The center frequency for aircraft and ground station transmission provides for spread-spectrum operation.

Welded circuits investigated for spread-spectrum equipment.

(2) Investigations are under way on the application of welded circuits to the final stage vehicle spread-spectrum equipment. Use of this approach appears to be very promising. However, use of high density packaging usually associated with the welded circuit technique probably will not be used because of the resulting thermal design problems and the inaccessibility for testing.

Ground station site criteria prepared. Microwave equipment specifications near completion.

(3) Site selection criteria for the communications subsystem ground station have been prepared. Preparation of specifications for satellite borne and ground station communications equipment is nearing completion. Consideration has been given to the terminal equipment for two ground stations.

Specific frequencies requested.

(4) The following specific frequency allocations for the communications subsystems are being requested:

Ground station-to-satellite - 7140 mc, 7580 mc, 8020 mc, 2160 mc.

Beacon tracking of satellite - 1770 mc, 1880 mc, 1990 mc, 2100 mc.

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SATURN PROJECT

Background of Project.

1. Background

a. The SATURN Project evolved as the earliest possible solution to the urgent need for boosting large payloads into orbit. The Army Ordnance Missile Command was assigned the project for demonstrating the feasibility of clustering available rocket engines to generate approximately one and one-half million pounds of thrust.

Development Operations Division of ABMA and SATURN Project are to be transferred to NASA.

b. As a result of the President's decision to transfer the Development Operations Division of the Army Ballistic Missile Agency and the SATURN Project to the National Aeronautics and Space Administration, technical supervision for the program has been assumed by NASA. Management supervision of the program temporarily remains with ARPA, and SATURN development remains the responsibility of Army Ordnance Missile Command until the transfer plan is approved by the Congress.

Booster contains eight Rocketdyne H-1 engines.

2. General.

a. The SATURN booster consists of three main sections: tail section, container section, and upper stage adaption section. The tail section will contain eight Rocketdyne H-1 engines. Final engines are expected to have a nominal sea-level thrust of 188,000 pounds each. Early flight engines are calibrated at 165,000 pounds thrust.

Nuclear powered upper stages for SATURN investigated.

b. A preliminary investigation has been completed on a nuclear, orbital, flight test vehicle. The investigation was based on the first two chemical stages of the SATURN C-2 vehicle with a ROVER-A nuclear engine stage on top. Additional consideration of the operational performance and overall configuration of the SATURN C-2 and C-3 Vehicles with ROVER-A indicates that a payload increase of two to three times that of the chemical counterpart can be achieved.

Preliminary design of control system circuit filters begun.

c. Preliminary design on control system circuit filters for the SATURN vehicle was begun. Preliminary investigations had shown the vehicle to be basically unstable due to low-frequency bending characteristics. The purpose of these filters is to provide the proper phase shift and attenuation in the control circuit to insure a stable control system throughout flight.

ABMA reviewing upper-stage proposals.

d. Army Ballistic Missile Agency

Army Ballistic Missile Agency briefed prospective contractors on the C-1 Vehicle second stage on 26 and 27 January. A total or 36 companies attended the conference. Proposals, including cost considerations and a transportation scheme, were received from 11 companies on 29 February 1960. Army Ballistic Missile Agency is now evaluating the proposals received. A decision by the Administrator of National Aeronautics and Space Administration as to the upper stage contractor is expected to be made by 1 April 1960. The contract will then be negotiated.

Test Vehicle SA-T installed in ABMA Static Test Tower.

3. Booster Vehicle Status

a. On 20 February 1960 SATURN Test Vehicle SA-T was transported to the Army Ballistic Missile Agency Static Test Tower from the assembly area and was installed in the tower. Preparations are in progress for engine installation. (See Figures 2 and 3)

The first full eight-engine captive firing of SA-T is scheduled for April 1960.

b. The current SATURN test schedule provides for one booster (SA-T) for captive test firings and one for each of four flight vehicles (SA-1, SA-2, SA-3, and SA-4). The first full eight-engine captive firing of SA-T is scheduled for April 1960.

SATURN instrumentation design, fabrication, and testing are scheduled.

4. Instrumentation

The vehicle circuits for SA-1 have been defined, and detail engineering for manufacturing of hardware is on schedule. Subsystems checkout equipment items are progressing satisfactorily in various stages of development.

First four engines for flight boosters accepted.

5. Test Program

a. Four production engines have completed acceptance testing (H-1011 through H-1014), and were accepted.

Nine engine tests were satisfactorily conducted.

b. Nine engine tests were conducted at the Army Ballistic Missile Agency Power Plant Test Stand during this report period. Engines H-1001 and H-1009, mounted in the outboard configuration, were used for the tests. Main objectives of these tests were the measurement of vibration levels on the fuel and liquid oxygen suction lines and engine system checkout in outboard configuration.

Captive test and launch facilities construction on schedule.

6. Facilities Status

a. Work is nearing completion on the "in-house" build-up of Army Ballistic Missile Agency's Static Test Tower. Work has been completed on the installation of control, facility, and instrumentation plumbing for the eight engines to be used in the SATURN cluster demonstration.

Blockhouse construction at AMR.

b. SATURN blockhouse construction at the Atlantic Missile Range is about 75 percent complete. (See Figure 4) Steel pan forms for concrete placement on the second floor were set in place and concrete poured. The ten-foot high concrete perimeter wall has been essentially completed. Construction work is also progressing satisfactorily on the launch pad.

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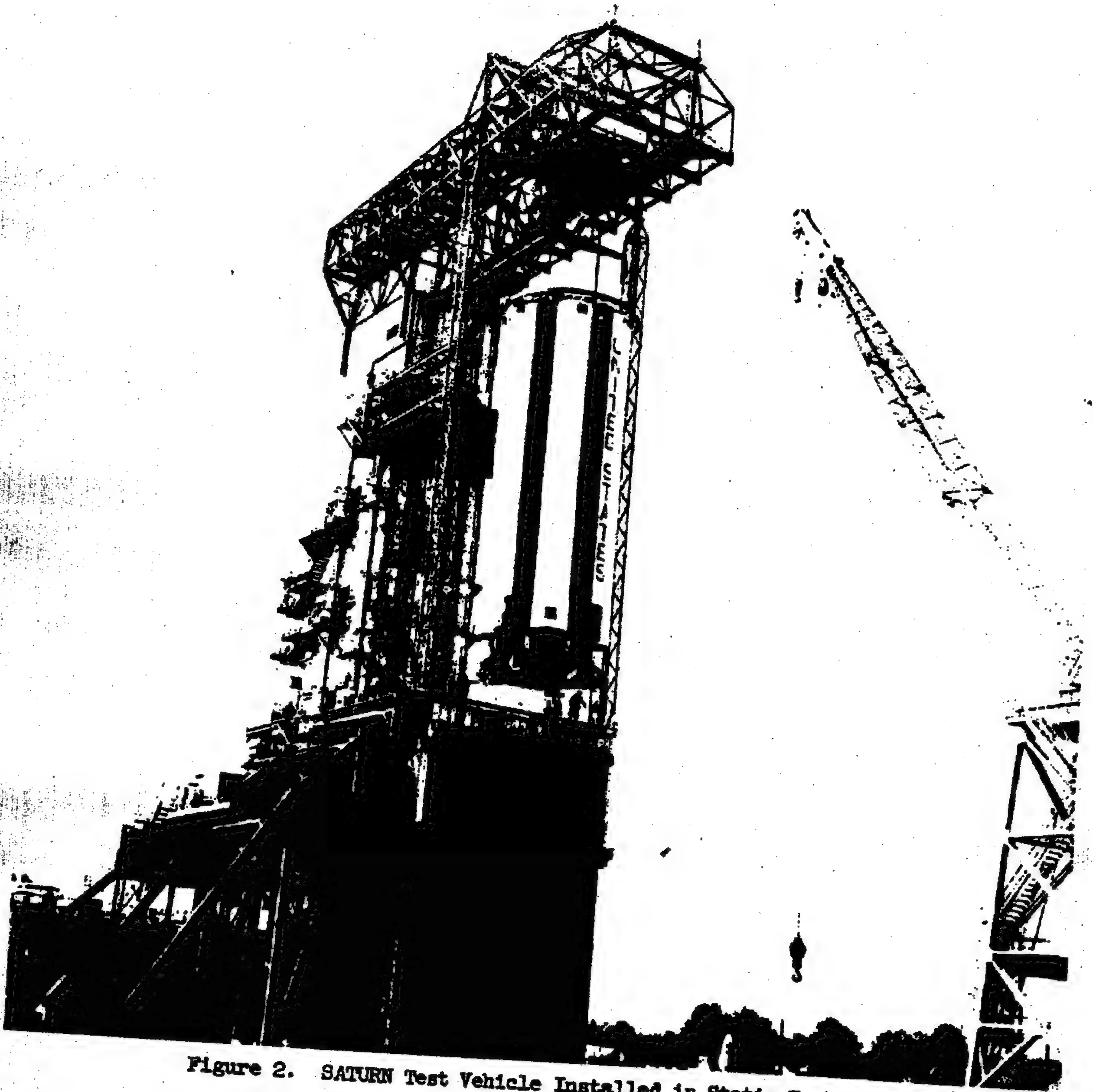

Figure 2. SATURN Test Vehicle Installed in Static Test Tower.

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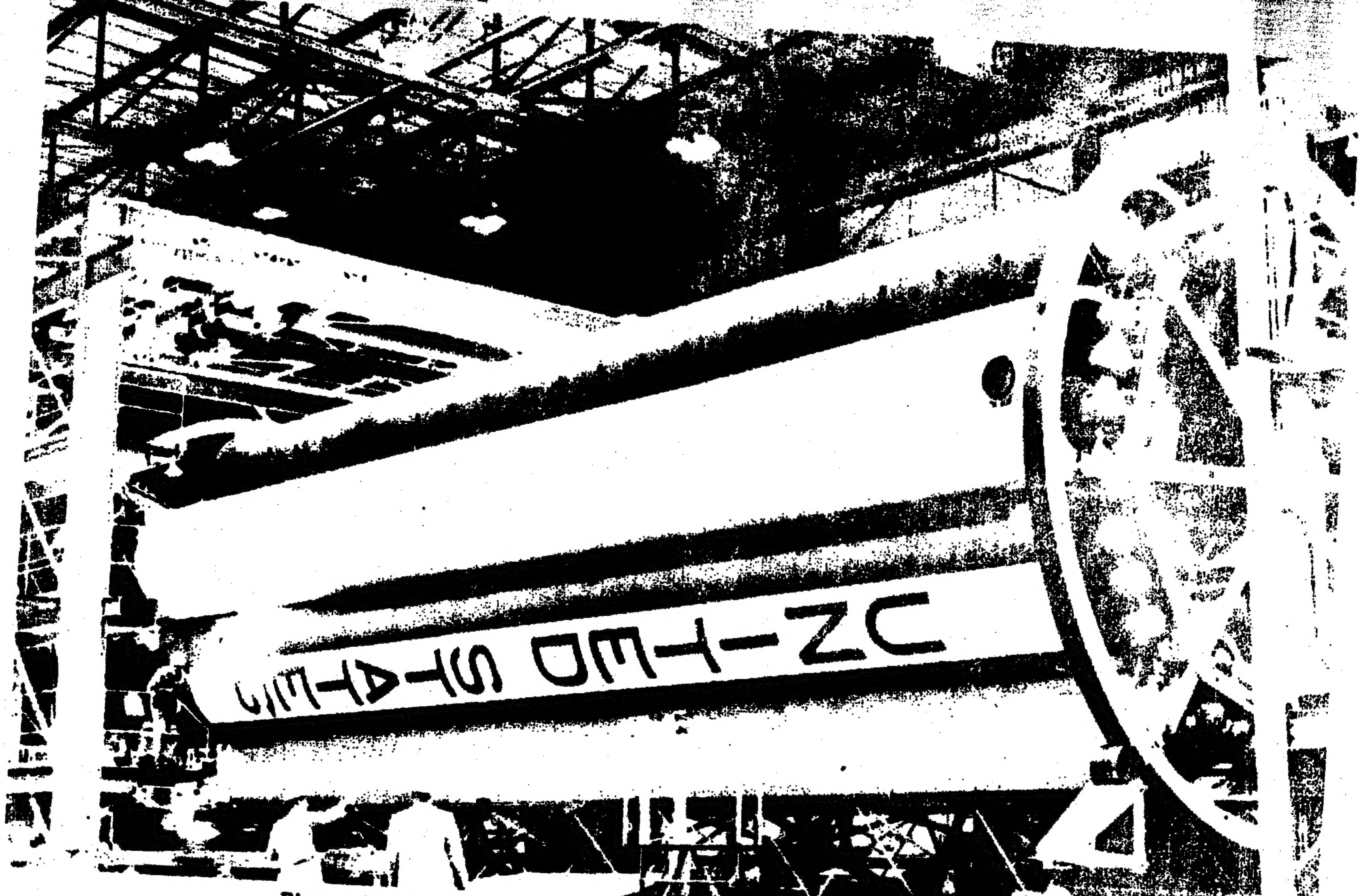

Figure 3. Structural Assembly of First SATURN Booster Container Unit.

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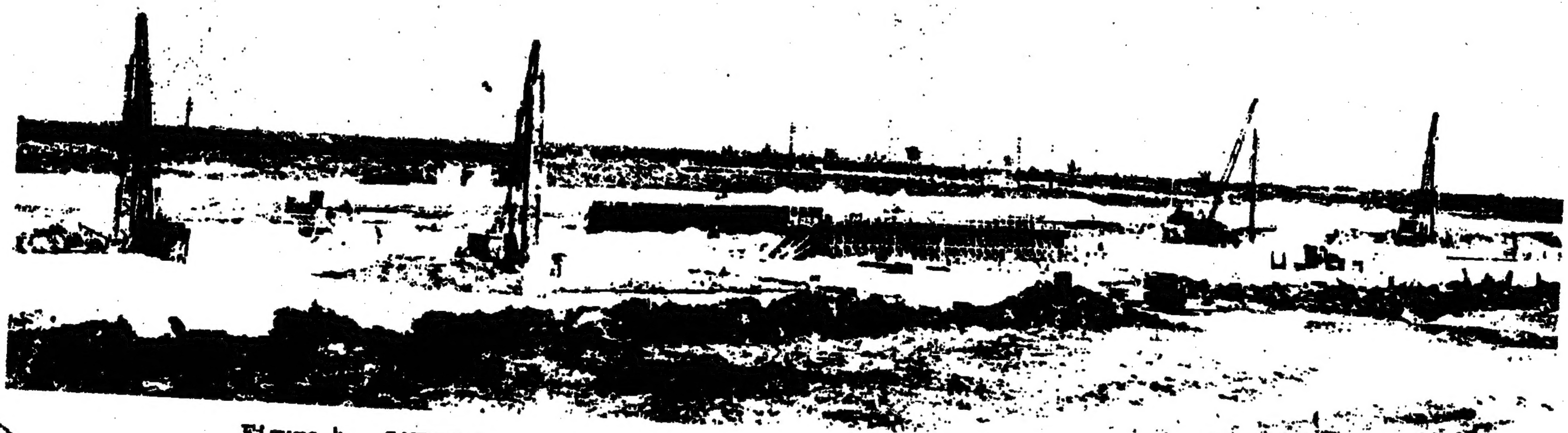

Figure 4. SATURN Launch Pad Under Construction at the Atlantic Missile Range.

STATUS OF FUNDS BY PROJECTS
(In Millions)

February 29, 1960

Project	Funding-FY 1959 and Prior Years	Amounts Programmed FY 1960	Cumulative Obligations	Cumulative Expenditures
DISCOVERER[1/] (R & D Satellites)	133.4	68.9	175.0	157.0
SAMOS[1/] (Reconnaissance Satellites)	105.6	159.5	190.0	128.3
MIDAS[1/] (Early Warning Satellites)	22.8	46.9	43.4	33.8
TRANSIT (Navigation Satellites)	10.6	16.8	14.9	9.4
NOTUS (Communication Satellites)	16.7	38.8	20.5	10.7
SHEPHERD (Tracking Network)	31.9	12.0	32.0	17.0
SATURN (Clustered Engine)	34.0	70.0	71.7	51.1

[1/] Excludes $84.1 programmed during Fiscal Year 1958 and prior years for WS 117L Program. DISCOVERER, SAMOS and MIDAS projects are outgrowths of WS 117L.

TENTATIVE DOD SATELLITE LAUNCH SCHEDULE

March 1960

PROGRAM	VEHICLE	LAUNCH SITE	CY 1960 Quarters				CY 1961 Quarters				CY 1962 Quarters			
			1	2	3	4	1	2	3	4	1	2	3	4
1. DISCOVERER	Thor-Agena	PMR	2	6	6	6								
2. Reconnaissance (SAMOS)	Atlas-Agena	PMR			1	1	1	2	2	3	4	2	2	
3. Communications (NOTUS)														
a. Delayed Repeater (COURIER I)	Thor-Epsilon	AMR		1	1									
b. SAC Polar (ADVENT)	Atlas-Agena	PMR							1	1	1	1		
c. 24 Hour (ADVENT)	Atlas-Centaur	AMR	Tentative										1	1
4. Navigation (TRANSIT) TRANSIT I, II	Thor-Epsilon	AMR		2		1								
5. Early Warning (MIDAS)														
Phase I	Atlas-Agena	AMR	1	1										
Phase II	Atlas-Agena	PMR				1	1	1	1	2	1	1		
6. SATURN	SATURN 1st Stage	AMR						1		1		1	1	